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ABSTRACT

A socioeconomic status (SES) and social support questionnaire was administered to the families of 559 singleton infants in a National Institute of Health collaborative study conducted at five university medical centers. A subset of six items measuring both SES and social support (which accounted for 87 percent of the common variance) was developed and entitled the Environmental Quality Index (EQI). These scores were summarized and separated into quartiles, and the performance of infants in the quartiles was compared on 9-, 18-, and 36-month outcome measures. Significant differences were found between EQI levels on 8 of 10 outcome measures, indicating the clinical usefulness of this new instrument. The EQI is appended. (Author/RH)

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The Environmental Quality Index:

A Tool for Developmental Outcome Studies

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Running head: EQI Composite

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Abstract

A socioeconomic status (SES) and social support questionnaire was administered to the families of 559 singleton infants in a five center NIH Collaborative Study. A subset of six items measuring both SES and social support, which accounted for 87% of the common variance, was developed and entitled the Environmental Quality Index (EQI). These scores were summarized, separated into quartiles, and the performance of infants in the quartiles was compared on 9, 18, and 36 month outcome measures. Significant differences were found between EQI levels on 8/10 outcome measures, indicating the clinical usefulness of this new instrument.

The Environmental Quality Index: A Tool for Developmental Outcome Studies

The quality of care of high risk infants frequently is evaluated by developmental outcome, assessed longitudinally. In addition, such follow-up studies often focus on the identification of pre- or perinatal variables, environmental/demographic factors, or neurobehavioral/developmental characteristics of the infant, which may affect outcome negatively (Aylward & Kenny, 1979; Ross, Schechner, Frayer & Auld, 1982; Sigman & Parmelee, 1979). Nonoptimal perinatal status may be tempered or exacerbated by the environment in some type of interaction (Werner, Simonian, Bierman, & French, 1967), but it now appears that the major impact on outcome is attributable to environmental factors (Bee, Barnard, Eyres, Gray, Hammond, Spietz, Snyder, & Clark 1982; Cohen & Parmelee 1983; Cohen, Sigman, Parmelee, & Beckwith, 1982; Sameroff, 1981; Siegel, 1982). Maternal education has often been identified as a potent environmental factor with respect to outcome (Smith, Flick, Ferris, & Sellman, 1972); it is probable, however, that maternal education is simply a marker variable for more general demographic or ecologic family characteristics (Bee et al, 1982).

The quality of the child's environment can be measured in a variety of ways: observation of caregiver-infant interaction (Parmelee & Sigman, 1979), amount of play materials available to the child (Bradley & Caldwell, 1976), verbal stimulation (Clarke-Stewart, VanderStoep & Killian, 1979), socioeconomic status (Hollingshead; 1975), or maternal/paternal education. Unfortunately, direct study of the infant's environment, such as observation of interactions or assessment of the home, is costly, and technically difficult. Indirect measurement of socio-economic status (SES) or maternal education is useful, but does not include other social support variables which also influence the child's outcome.

Hence, there is a need for an economical, easily administered tool to measure the child's environment, including the social support network available to the family as a whole. The purpose of this report is to describe such a tool and demonstrate its clinical utility.

Method

Subjects

Subjects were enrolled in the NIH Collaborative Study to assess the efficacy of antenatal dexamethasone administration in the prevention of respiratory distress syndrome (RDS). A more detailed description of the study rationale and the subject population can be found elsewhere (Collaborative Group on Antenatal Steroid Therapy, 1981). Briefly, from a total of 606 singleton babies, SES and social support data were obtained on 559 infants. Procedural problems and refusal by the families to participate further were the cause for data loss in the infants for whom no environmental data were obtained.

The subjects were born at one of five participating university centers: Miami, Wisconsin (Madison), Manitoba (Winnipeg), Tennessee (Memphis), and Northwestern (Chicago). Fifty-four percent of the infants were male. With

respect to race, 45% were white, 45% black, and 10% other (American Indian, Hispanic, or Eskimo) (Table 1). Informed consent was obtained in compliance with federal and institutional regulations.

Table 1

Demographic Characteristics By Center

	Center				
Race (%)	Madison	Manitoba	Memphis	Miami	Northwestern
White	96.3 (52)	84.3 (113)	22.9 (52)	16.1 (13)	31.8 (20)
Black	3.7 (2)	1.5 (2)	76.7 (174)	64.2 (52)	33.3 (21)
Other	0 (0)	14.2 (19)	0.4 (1)	19.8 (16)	34.9 (22)
Males	51.9 (28)	58.2 (78)	52.0 (118)	55.6 (45)	54.0 (34)
Females	48.1 (26)	41.8 (56)	48.0 (109)	44.4 (36)	46.0 (29)
GA < 37 Weeks (Dubowitz)	81.1 (43)	80.2 (101)	76.2 (173)	84.0 (68)	83.9 (52)

Apparatus

SES Questionnaire. An SES and Social Support Systems questionnaire was developed for the NIH study (Manual of Operations, 1977). The social support systems component contained data from 4 areas: a) geographic mobility; b) social alienation from potentially supportive persons outside the immediate family; c) integration of the father into the family; and d) the mother's involvement with social institutions which may be supportive of the parent-child unit during times of stress. The socioeconomic component included a modification of the Hollingshead Index which was suitable for both two-parent and single-parent families. The index utilized either the higher educational level and occupational attainment of the two parents, or the score for the responsible parent in a single-parent family.

Twenty-six items measured social support systems, and 12 items evaluated socioeconomic status (SES). Of these, 8 items required more lengthy, written

answers, and hence were not included in the analyses. The information obtained was used to generate 13 variables measuring various aspects of socioeconomic status and social support of the mothers who participated in this study (Table 2).

Table 2

Variables Analyzed

Variable #	Name	Scoring	Description
1	Mobility Index	(0 - 2)	Sum of moves; plans for moving.
2	Social Support 1 (Relative)	(0 - 2)	Number of times per week person talked to relative.
3	Social Support 2 (Friend)	(0 - 2)	Number of times per week person talked with close friend.
4	Helping out with baby	(0 - 3)	Sum of whether or not someone is available to take care of baby; whether someone could care for baby if mother worked.
5	Availability of car	(0 - 2)	Sum of having a telephone and/or a car or phone
6	Integration of Male	(0 - 5)	Sum of 5 indicators reflecting male involvement (eating with family, doing house hold chores, playing with children, attending childbirth classes, taking mother to doctor).
7	Involvement with Social Institutions	(0 - 2)	Level of involvement with church, clubs, or community groups.
8	Freedom from Public Assistance	(0 - 1)	0 if mother received any of the following benefits: housing, unemployment, workman's compensation, disability payments, ADC or other public asstance.
9	Availability of Help	(0 - 2)	Sum of help available when needed, and availability of doctor.
10	Mother's education	(0 - 4)	$<$10 years=0; 10-11=1; 12=2; 13-15=3; $\geq$ 16=4.
11	Father's education	(0 - 4)	Same as above.

Table 2 (Continued)

Variables Analyzed

Variable #	Name	Scoring	Description
12	Unemployment Index	(0 - 1)	1 if father was unemployed > 4 weeks during last year.
13	Family Occupational	(1 - 4)	Professional, tech., managers=4; Index Sales, blue-collar supervisor=3; Skilled trades=2; unskilled-1.[a]

[a] If father's occupation was not available, then mother's occupation was coded.

Procedure

The data were obtained in an interview format as part of the standard research protocol. The questionnaire was administered by a social worker or research nurse at each infant's first appointment for developmental follow-up. Portions of the interview were updated at 9 and at 18 months but these data will not be included in this report. Specific instructions for administration were outlined in a procedural format (Manual of Operations, 1977). Various measures of cognitive and motor development were taken at 9, 18, and 36 months of age (corrected for prematurity) as part of the research protocol. The Bayley Scales of Infant Development were administered at 9 and 18 months; the McCarthy Scales of Children's Abilities were given at 36 months.

Statistical Analysis. The goal of the variable construction and subsequent analyses was to reduce the information contained in the interview form to a few basic dimensions which would summarize this information adequately and also be useful for further modeling efforts. The formation of the 13 variables resulted in substantial reduction of the original number of data elements. Factor analyses were performed to determine if these 13 variables could be explained by a few useful, underlying dimensions, i.e. a SES factor and a social support factor. The 13 variables were intercorrelated and subjected to a principal components factor analysis with a varimax rotation. Missing data were generally not a problem. When missing data occurred they were logically imputed.

Application of the new measure to outcome data was evaluated by the use of t-tests and trend analyses.

Results

Development of the EQI Composite

The intercorrelations of the 13 variables are presented in Table 3. Note that the intercorrelations are generally low.

Table 3

Correlation Matrix

	Variable 1	Variable 2	Variable 3	Variable 4
Variable 1	1.00000	0.05053	-0.02061	0.04407
Variable 2	0.05053	1.00000	0.14340	0.18881
Variable 3	-0.02061	0.14340	1.00000	0.10810
Variable 4	0.04407	0.18881	0.10810	1.00000
Variable 5	0.03304	-0.07597	-0.00027	0.07680
Variable 6	-0.03135	-0.28425	-0.08415	-0.06742
Variable 7	-0.07196	0.04465	0.05275	0.07798
Variable 8	-0.13017	-0.15481	-0.01845	-0.03829
Variable 9	0.02168	0.09919	-0.03561	0.09808
Variable 10	-0.03423	-0.19541	-0.08408	-0.05556
Variable 11	0.00018	-0.18332	-0.08854	-0.04727
Variable 12	0.12782	0.01302	0.00192	-0.05932
Variable 13	-0.03024	-0.22013	-0.05019	0.14179

	Variable 5	Variable 6	Variable 7	Variable 8
Variable 1	-0.03304	-0.03135	0.07196	-0.13017
Variable 2	-0.07597	0.28425	0.04465	-0.15481
Variable 3	-0.00027	-0.08415	0.05275	-0.01845
Variable 4	0.07680	-0.06742	0.07798	-0.03829
Variable 5	1.00000	0.30922	0.21765	0.20247
Variable 6	0.30922	1.00000	0.11116	0.46086
Variable 7	0.21766	0.11116	1.00000	0.07853
Variable 8	0.20247	0.46086	0.07853	1.00000
Variable 9	0.25558	0.12923	0.12397	0.04792
Variable 10	0.23960	0.25289	0.09889	0.20740
Variable 11	0.23471	0.26658	0.09050	0.24385
Variable 12	-0.00910	-0.01868	0.07611	-0.12444
Variable 13	0.19350	0.34832	0.03174	0.30300

	Variable 9	Variable 10	Variable 11	Variable 12	Variable 13
Variable 1	0.02168	-0.03423	0.00018	0.12782	-0.03024
Variable 2	-0.09919	-0.19541	-0.18332	0.01302	-0.22013
Variable 3	-0.03561	-0.08408	-0.08854	0.00192	-0.05019
Variable 4	0.09808	-0.05556	-0.04727	-0.05932	-0.14179
Variable 5	0.25558	0.23960	0.23471	-0.00910	0.19350
Variable 6	0.12923	0.25289	0.26658	-0.01868	0.34832
Variable 7	0.12397	0.09889	0.09050	0.07611	0.03174
Variable 8	0.04792	0.20740	0.24385	0.12444	0.30300
Variable 9	1.00000	0.05815	0.04009	0.00222	0.05318
Variable 10	0.05815	1.00000	0.53994	0.02703	0.40560
Variable 11	0.04009	0.53994	1.00000	0.04807	0.45753
Variable 12	0.00222	0.02703	0.04807	1.00000	-0.10507
Variable 13	0.05318	0.40560	0.45753	-0.10507	1.00000

The principal factor analysis resulted in only one eigenvalue greater than 1. Hence the remaining factors were dropped from further consideration. The difference between the first and second eigenvalue was considerable (Table 4). The loadings of the 13 variables on the first principal factor are presented in Table 5. While this factor only accounted for 16% of the total variance, it did account for 87% of the common variance of the 13 variables. The variables had much unique variance associated with them. Some of the variance resulted from measurement error, whereas the commonality estimates have also been attenuated by the diverse marginal distributions, thus upwardly biasing the unique variance estimates.

Table 4

Eigenvalues

	Variable 1	Variable 2	Variable 3	Variable 4
Eigenvalues	2.107871	0.554464	0.425330	0.262035
Portion	0.871	0.229	0.176	0.108
Cumulative Portion	0.871	1.100	1.275	1.384

	Variable 5	Variable 6	Variable 7	Variable 8
Eigenvalues	0.097056	0.073503	-0.033535	-0.088088
Portion	0.040	.030	-0.014	-0.036
Cumulative Portion	1.424	1.454	1.440	1.404

	Variable 9	Variable 10	Variable 11	Variable 12	Variable 13
Eigenvalues	-0.140756	-0.167925	-0.188414	-0.216771	-0.263814
Portion	-0.058	-0.069	-0.078	-0.090	-0.109
Cumulative Portion	1.346	1.276	1.199	1.109	1.000

Table 5

Intercorrelations

Factor Pattern

	Factor 1	
Variable 1	-0.08223	Mobility
Variable 2	-0.35605	Social support 1
Variable 3	-0.12308	Social support 2
Variable 4	-0.11299	Help with baby
Variable 5	0.41642	Car or phone
Variable 6	0.59290	Integration of male
Variable 7	0.15945	Social institutions
Variable 8	0.49762	Public assistance
Variable 9	0.17138	Availability of help
Variable 10	0.59538	Mother's education
Variable 11	0.62441	Father's education
Variable 12	-0.04455	Unemployment
Variable 13	0.61051	Family occupation

Variance Explained By Each Factor

Squared Multiple Correlations of the Variables with Each Factor
Scoring Coefficient Matrix
Factor 1
0.753349

	Factor 1	
Variable 1	-0.02563	Mobility
Variable 2	-0.10341	Social support 1
Variable 3	-0.03199	Social support 2
Variable 4	-0.03150	Help with baby
Variable 5	0.12955	Car or phone
Variable 6	0.23395	Integration of male
Variable 7	0.04314	Social institutions
Variable 8	0.16354	Public assistance
Variable 9	0.05301	Availability of help
Variable 10	0.21746	Mother's education
Variable 11	0.24574	Father's education
Variable 12	0.01396	Unemployment
Variable 13	0.21851	Family occupation

The pattern of loadings indicated that the first principal factor contained a blend of SES and social support variables (primarily the former), and hence the dimension can be considered to measure the overall quality of the environment. We termed this factor the Environmental Quality Index (EQI). The variables were: mother's education, father's education, family occupation, integration of male, availability of car or phone, and freedom from public assistance. The coefficients for generating the factor scores are also presented in Table 5. These are the multiple regression weights that predict the factor score from the 13 variables. The multiple correlation of the variables with this factor was .87. The largest scoring coefficients (i.e., the most important variables) correspond to the variables that had the highest factor loadings. The composite questionnaire is found in the Appendix.

The data were also separated and factor analyzed by individual center, to determine whether the composite factor would be applicable to situations with a different subject composition. In general, the center-specific factor analyses agreed with the factor analytic results for the total sample, thus supporting a wide range of application.

The means and standard deviations of each variable are found in Table 6. Variables 5, 6, 8, 10, 11 and 13 were included in a composite score. The EQI composite score was formed by summing the standardized scores for the six variables. The composite score distribution was then categorized into three levels: upper quartile, middle two quartiles, and lower quartile.

Application of EQI Composite Score

Subjects falling in each of these EQI categories were compared on the Mental Developmental Index (MDI) and Psychomotor Developmental Index (PDI) of the Bayley Scales at 9 and 18 months. Comparisons between groups were also made on the five subscales and the General Cognitive Index (GCI) of the McCarthy Scales (MSCA) at 36 months. Significant differences between the EQI composite composite groups were found on the 9 month MDI and PDI, the 18 month MDI, and 4 out of 5 subscales of the MSCA, as well as the General Cognitive Index. In general, there was a positive relationship between developmental test scores and the EQI Composite rankings; lower test scores were associated with lower quartiles. (Table 7).

Table 6

Means and Standard Deviations

	Variable 1	Variable 2	Variable 3	Variable 4
Mean	0.59750	1.38462	1.03220	1.51699
Standard Deviation	0.68580	0.80356	0.85658	0.67147

	Variable 5	Variable 6	Variable 7	Variable 8
Mean	1.61538	2.01789	0.68157	0.62612
Standard Deviation	0.59615	1.74844	0.82231	0.48427

	Variable 9	Variable 10	Variable 11	Variable 12	Variable 13
Mean	1.64758	1.64937	1.63148	0.14848	1.85868
Standard Deviation	0.56729	1.13693	1.21378	0.35589	1.01938

Number of Observations = 559

Table 7

EQI-Composite Quartiles and 9, 18, & 36

Month Outcome Measures

	Upper Quartile	25%-75%	Lower Quartile	P-Value[a]
9 Month Bayley				
Mental Scale	108.5 (112)	103.4 (195)	99.1 (90)	**
Motor Scale	103.8 (112)	101.7 (194)	97.6 (91)	*
18 Month Bayley				
Mental Scale	104.5 (105)	96.6 (169)	90.0 (69)	**
Motor Scale	102.0 (103)	100.2 (168)	97.5 (70)	NS
McCarthy Scales				
Verbal	51.8 (84)	43.5 (125)	41.9 (52)	***
Perceptual	53.0 (85)	45.4 (127)	44.0 (53)	***
Quantitative	51.0 (85)	45.4 (125)	44.3 (52)	**
GCI	103.6 (83)	90.3 (124)	87.4 (52)	***
Memory	50.5 (83)	46.2 (123)	45.5 (52)	*
Motor	52.0 (83)	49.8 (124)	50.6 (51)	NS

* $p < .05$
** $p < .01$
*** $p < .001$

[a] Adjusted For Center

Descriptive trends were also noted, which reflect a decline in cognitive test scores over time. This decline corresponded to a decrease in EQI Composite quartiles. A significant decline in scores over time (i.e., between 9 month MDI, 18 month MDI, and 36 months GCI), was found in the low SES quartile ($p = .01$) and in the middle quartiles ($p = .0001$). This decline was not significant for the top quartile ($p = .07$). A significant overall between - group difference with respect to decline in test scores was found ($p < .05$).

Discussion

This study describes both the development and the application of a simple, yet useful questionnaire that can be used to measure the quality of a child's environment. The instrument is defined by both SES and social support variables, (primarily the former) and hence can be considered to evaluate family ecology in a general sense. It is probable that some of the items, such as availability of a car or phone, are marker variables which reflect a broader underlying influence. Nonetheless, the identification of such variables does enable the effects of these broader underlying influences to be measured, albeit in a somewhat indirect manner.

Application of the quartile EQI composite concept would be useful in controlling for the quality of the environment when treatment groups are compared. The composite can also be used as a control variable with continuous scores. In fact, such an approach is being used currently in the comparison of placebo and steroid-exposed babies in the NIH Collaborative Antenatal Steriod Study. With such analyses, the effects of the treatment or intervention that is under consideration can be measured within each EQI group, thereby enabling assessment of possible interactive effects of environment and treatment.

It is reasonable to assume that different quartiles may be developed for other subject samples. Such a procedure will not detract from the utility of the EQI composite; in fact, the use of values that are sample-specific may enhance the applicability of the instrument. The wide range of applicability is supported further by the fact that the data from the individual participating centers were similar to the overall group factors.

Table 7 reveals descriptive trends which reflect a decline in developmental test scores with a corresponding decrease in EQI quartiles. This decline is particularly evident in the cognitive measures at each age level. These data are in agreement with previous studies which emphasize the increased importance of environmental influences with increasing age, particularly with respect to cognitive abilities (e.g., Siegel, 1982). Of note also is the decline in scores over time within each EQI composite level. These declines appear more substantial in the lower and middle quartile groupings as compared to the upper quartile. This probably reflects a further advantage of environmental stability and support; namely, a more stable developmental pattern of mental growth over a broad time span in infancy and early childhood. The progressive decline of test scores in the lower and middle quartile groups appears related to a slow but cumulative mal-effect of a depressed and/or non-supportive environment during the early years.

Most striking is the extent to which these environmental influences act on developmental outcome in this biologically high risk group. A question for further study relates to whether this negative developmental effect acts as a main effect across all groups or whether there is an interactive effect with this particular type of high risk group (primarily preterm infants). Others have also noted the importance of "transactional" effects between the high risk child and the care-taking environment (Sameroff & Chandler, 1975) as well as the amplification of IQ deficits in children with organic impairments as a result of cultural and economic disadvantages (Bromon, Nichols & Kennedy 1975).

It remains to be seen to what extent high risk follow-up studies may be flawed by failure to more completely control for the potent environmental influences described in the EQI composite.

In conclusion, a combined measure of more traditional SES and newer social support variables, with a wide range of clinical utility has been described. Initial application of the EQI-Composite to 9, 18, and 36 month outcome measures is encouraging, and such a tool would be useful in partialling out the effects of the environment in future follow-up studies.

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Footnotes

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Appendix

Environmental Quality Index (EQI)

1. Mother's education (Number of years of formal education completed). (0-4)

≤ 10	= 0	____
10 - 11	= 1	____
12	= 2	____
13 - 15	= 3	____
≥ 16	= 4	____

SUM MED ____

2. Father's education (Number of years of formal education completed). (0-4)

Scoring same as above ____

SUM FED ____

3. Family Occupation[a] (1-4)

Professional, technical, managers	= 4	____
Sales, blue-collar, supervisor	= 3	____
Skilled trades	= 2	____
Unskilled	= 1	____

SUM FO ____

4. Integration of Male (Check if "yes") (0-5)

Did/does baby's father

a) Attend childbirth classes with mother? ____
b) Take mother to physician or prenatal clinic? ____
c) Have meals with family > 3 times per week? ____
d) Help with household chores (making meals, cleaning up, taking trash out, fixing things) > 3 times per week? ____
e) Help or play with children in family > 3 times per week? ____

SUM IOM ____

5. Availability of car or phone (0-2)

Is there a car available to mother? ____
Is there a telephone available to mother? ____

SUM ACOP ____

6. Freedom from public assistance (0-1)

Does mother receive:

a) Housing benefits ____

b) Unemployment benefits ____

c) Workman's compensation ____

d) Disability payments ____

e) Aid to Families of Dependent Children (AFDC) ____

f) Other public assistance ____

If any of above are checked, score = 0

SUM FPA ____

EQI Total Score
(Sum of items 1-6) ____

[a] If father's occupation not available use mother's.